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(12) # EUROPEAN PATENT APPLICATION

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(71) Applicant: TECHNICARE CORPORATION
90 Inverness Circle East
Englewood Colorado 80112(US)

(72) Inventor: Gardineer, Bayard G.
6, Pine Brae Drive
Skillman New Jersey(US)

(74) Representative: Jones, Alan John et al,
CARPMAELS & RANSFORD 43 Bloomsbury Square
London, WC1A 2RA(GB)

(54) **Low pressure fluid-filled ultrasound transmission chamber.**

(57) An adjustable volume fluid reservoir for maintaining a low pressure head in an ultrasound beam transmitting fluid-filled chamber to prevent formation of air bubbles therein.

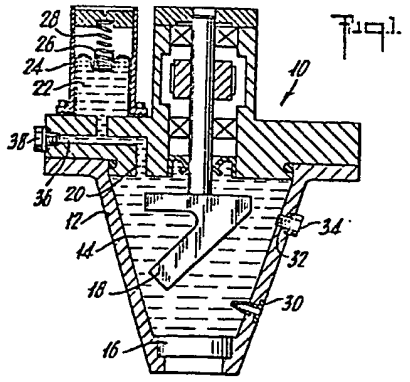

Fig. 1.

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TITLE MODIFIED
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LOW PRESSURE HEAD FLUID RESERVOIR

BACKGROUND OF THE INVENTION

Ultrasound imaging apparatus for scanning e.g. the human body are known in the art. A typical apparatus uses a fluid-filled chamber to transmit ultrasonic beams and their reflections to and from the transducer and the body being scanned. Any air bubbles present in the fluid-filled chamber disrupt the transmission of the ultrasound beams and distort an image of the reflected beams. When filling the chamber care must be taken to avoid leaving bubbles of air. But, as most seals will leak, at least to a minor degree, the fluid seal of the chamber will leak over time, permitting the formation of air bubbles. It is believed that fluid leakage reduces the pressure in the chamber allowing entrained air in the remaining fluid to form air bubbles. Further reduction of the pressure produces air filled voids. This results in the constant need to monitor for air bubbles formation and to refill the chamber; both of which limit the scan time of the apparatus.

SUMMARY OF THE INVENTION

The present invention comprises providing the fluid-filled chamber of an ultrasound beam transmitting apparatus with an adjustable effective volume to maintain a low pressure head in the chamber and prevent air bubble formation therein. When it is undesirable to directly adjust the volume of the fluid-filled chamber, additional reservoirs of fluid may be connected to the chamber, and the effective volume and pressure of the fluid-filled chamber adjusted by changing the volume of the additional fluid reservoirs. The additional reservoirs may be totally contained within the housing of the ultrasound apparatus or may be separable therefrom and may comprise an addition

to an existing apparatus. The reservoir may incorporate already existing fluid reservoirs within an existing system e.g. means for regulating fluid pressure within the chamber according to fluctuations in atmospheric pressure. The adjustable volume of the reservoir allows the fluid in the chamber to be replenished without disrupting the use of the apparatus. When permanently contained within the housing of the apparatus, the reservoir may comprise a bladder or rolling diaphragm which is pressurized preferably to 4-5 pounds per square inch. Pressure may be maintained on the diaphragm by means of a piston urged against the diaphragm by a spring mounted on the housing. The volume of both the reservoir contained within the housing or the separable reservoir for attachment to the chamber may be varied by operator adjustment means which may comprise a turn screw urging a piston against the reservoir. The use of the pressurized reservoir of additional fluid substantially increases the time period during which the scanning apparatus may be used before refilling of the chamber or reservoir. The chamber is initially filled with fluid and may be replenished by refilling the reservoir through a duck-billed check valve, which permits accurate pressurization of the chamber. In addition, the chamber may be provided with a resealable fluid tap to allow bubbles in the chamber to be expelled therethrough.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a partial cross section of a preferred embodiment of the present invention.

Figure 2 is a partial cross section of another embodiment of the present invention.

DESCRIPTION OF THE INVENTION

The preferred embodiment of the present invention is depicted in Figure 1 where the ultrasound apparatus is shown generally at 10. The apparatus comprises a housing 12 containing a fluid-filled chamber 14, transducer 16 and reflecting means 18 are mounted within the chamber. The apparatus further comprises a transducer, and option reflecting means to transmit and/or receive ultrasonic beams through the fluid-filled chamber. In the embodiment shown, the fluid-filled chamber is connected as by passage 20 to a fluid reservoir 22 containing additional fluid. The fluid reservoir may be constructed of a rolling diaphragm 24 and may be pressurized by a piston 26 urged against the diaphragm by a spring 28 mounted to the housing. Alternatively, the reservoir may comprise a piston, bladder, or hydraulic accumulator or other construction that produces a change in volume in response to a change in pressure. In addition, operator adjustment means such as a preloaded screw may be provided to urge the piston against the diaphragm. In use the fluid within the reservoir 22 replenishes the fluid in the main chamber 14 and maintains a low pressure head thereby preventing the formation of air bubbles, and compensates for voids created by leakage. Initial filling and subsequent refilling of the chamber is accomplished through a one way valve, such as the duck-billed check valve 30. An opening 32 in the chamber with a seal screw 34 or other removable elastomeric seal allows removal of any bubbles in the chamber. The apparatus may also be provided with an opening 36 to the passage 20, with a removable elastomeric seal 38 to allow purging of air during the fill procedure.

Figure 2 illustrates an alternative embodiment of the present invention wherein an additional fluid reservoir is provided in a second chamber 100 which may be separably connected to the fluid-filled chamber of an existing

ultrasound apparatus. The apparatus shown generally at 101 comprises a housing 102 and a fluid-filled chamber 104. As illustrated, the chamber has a transducer means 106 and reflecting means 108 disposed therein. The apparatus also has existing fluid reservoirs, e.g. bellows 110 and 112 provided to allow adjustment for the fluid pressure according to atmospheric pressure. When the bellows are filled, buttons 111 and 113 are visible. Refilling of the chamber is necessary when the buttons disappear from view.

Additional fluid reservoir 100 is adapted to connect with the main chamber to replenish the fluid therein and maintain a low pressure head in the chamber. The volume of the reservoir may be adjusted by means of a piston 122 urged against the reservoir. Preferably, adjustment of the piston is continued until the buttons 111 and 113 reappear. Numerous means, known to those skilled in the art, may be used to move the piston against the reservoir; and the screw cap 124 illustrated in Figure 2 is one such means.

The fluid-filled bellows are connected to the main chamber by ducts 114 and 116, and this embodiment of the invention further encompasses utilizing the fluid in bellows 110 and 112 together with the additional reservoir 100 to maintain the fluid in the chamber thereby increasing the effective volume of the second chamber. To ensure that the fluid within the bellows does not contain air bubbles as a result of fluid- filling procedures, removable elastomeric seals may be provided at 118 and 120 to allow purging of air in the bellows during the fill procedure. In addition an opening in the chamber, 126, provided with seal screw 128 or other removable elastomeric seal, will allow removal of bubbles in the chamber.

When the additional fluid in the reservoir has been exhausted, the chamber 100 may be refilled. After loosening seal 128, screw cap 124 may be loosened and piston 122 pulled out of chamber 100, and the chamber refilled directly. Alternatively, the piston may be reset within the chamber, the screw cap refastened, and the chamber 104 and chamber 100 refilled through opening 126 or a duck-billed valve such as shown in Figure 1 at 30.

The foregoing description of the drawings is illustrative and is not to be taken as limiting, still other variations and modifications are possible without departing from the spirit and scope of the present invention.

Claims:

1. In an ultrasound beam transmission system, a fluid-filled housing for ultrasound transmission apparatus comprising:

a main fluid-filled chamber containing at least a portion of said transmission apparatus;

an adjustable volume fluid reservoir connected to said chamber for maintaining a low pressure head in said housing; and

a one-way check valve located in a wall of said housing for pressurizing said housing with fluid.

2. An ultrasound apparatus as set forth in Claim 1, wherein said fluid reservoir comprises a second chamber separably connected to said main chamber.

3. An ultrasound apparatus as set forth in Claim 1 or 2 wherein said pressure head is about 4 - 5 psi.

4. An ultrasound apparatus as set forth in Claim 1, wherein said fluid reservoir comprises a pressurized fluid-filled rolling diaphragm.

5. An ultrasound apparatus as set forth in Claim 4 wherein pressure is maintained on said rolling diaphragm by a piston in contact with an outside surface of said diaphragm, said piston being urged against said diaphragm by a spring mounted to the housing.

6. An ultrasound apparatus as set forth in Claim 4 or 5 wherein the pressure on said rolling diaphragm may be increased by a turn screw knob and a piston, wherein said turn screw knob advances said piston against the outside surface of the diaphragm.

7. An ultrasound apparatus as in Claim 2 or 3 further comprising an existing fluid reservoir coupled to said chamber and said fluid reservoir, for increasing the effective volume of said fluid reservoir beyond that of the second chamber.

8. Method of preventing air bubble formation in an ultrasonic beam transmitting fluid-filled chamber to prevent air bubble formation therein, said method comprising maintaining a low pressure head in the fluid-filled chamber.

9. A method as in Claim 8 wherein said low pressure head is maintained by adjusting the effective volume of the fluid-filled chamber.

10. A method as in Claim 8 wherein the low pressure head is maintained by adjusting the volume of a reservoir of additional fluid connected to said chamber.

11. A method as in Claim 9 further comprising coupling existing fluid reservoirs to said chamber and said fluid reservoir.

12. An improved ultrasound beam transmitting fluid-filled chamber as in any one of Claims 1 to 7, further including means connected with said housing for expelling air bubbles from said chamber, said means comprising an opening in said chamber with a removable seal.

Fig.2.

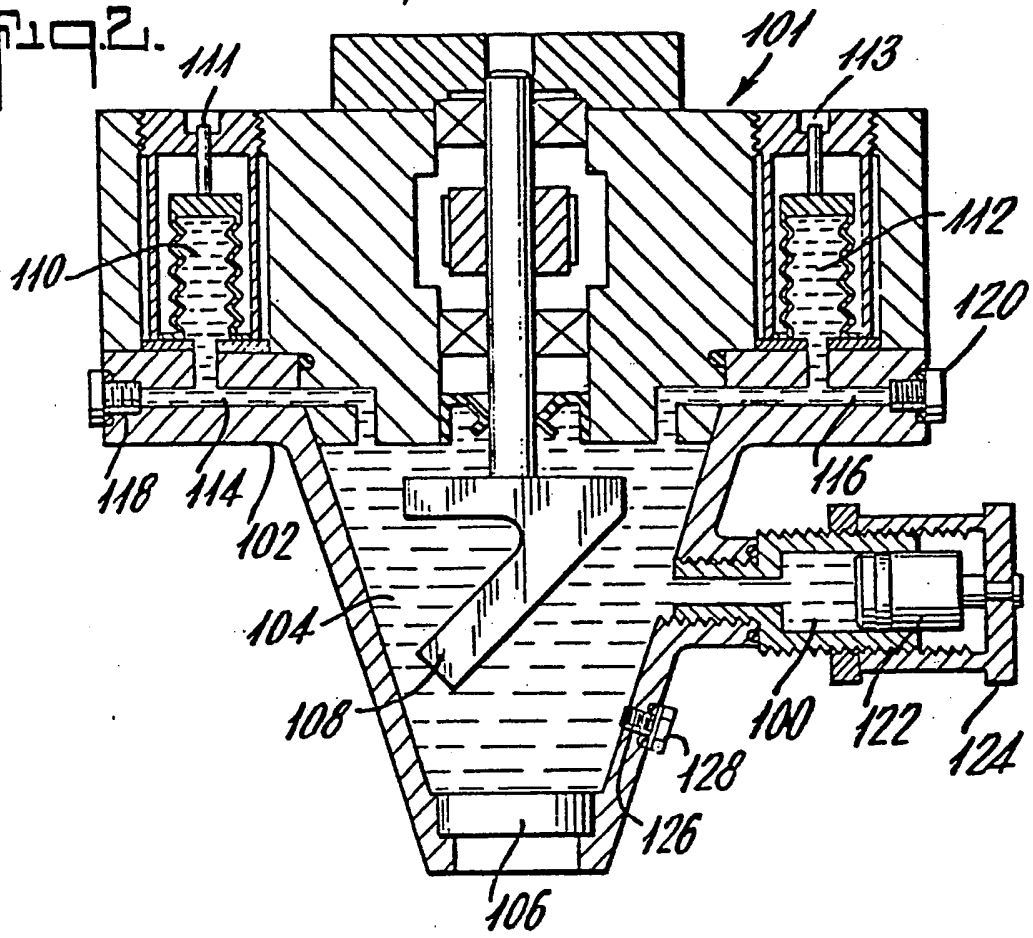
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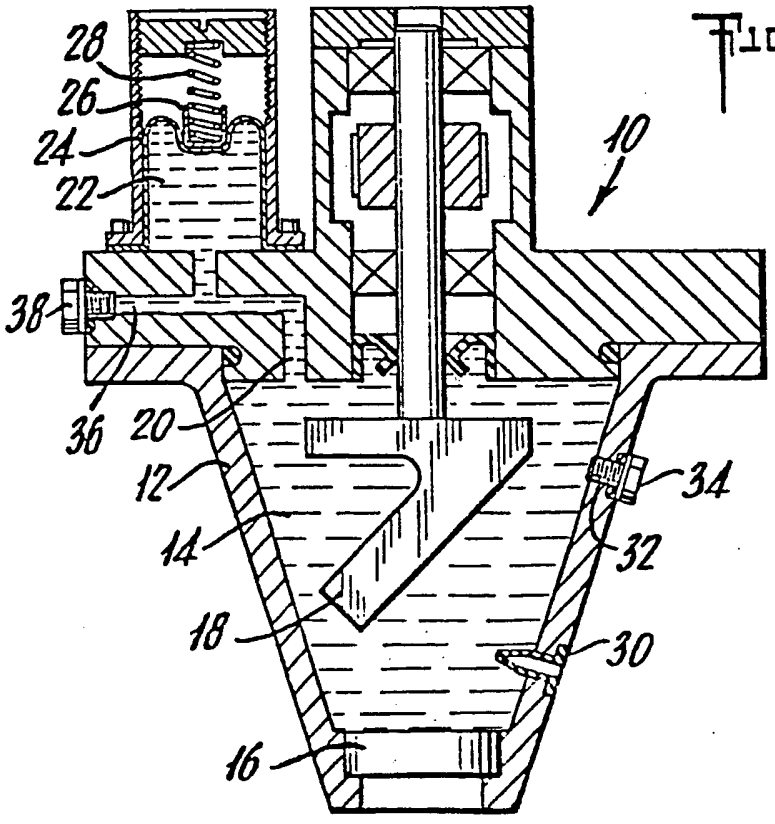
Fig.1.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(71) Applicant: TECHNICARE CORPORATION
90 Inverness Circle East
Englewood Colorado 80112(US)

(72) Inventor: Gardineer, Bayard G.
6, Pine Brae Drive
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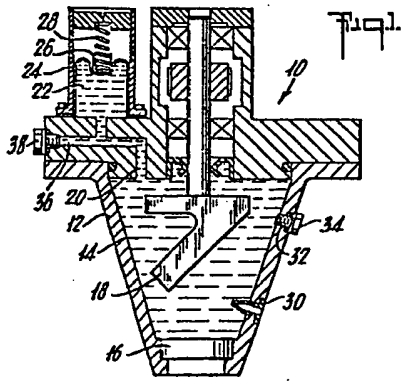

Fig. 1.

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EUROPEAN SEARCH REPORT

Application number

EP 83 30 0990

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X,Y	US-A-4 181 120 (TOKYO SHIBAURA ELECTRIC CO.LTD.) * column 4, line 40 - column 5, line 3; figure 3b *	1,2,3, 8,10, 12	G 10 K 11/00 B 06 B 3/00
Y	US-A-4 316 271 (HONEYWELL INC.) * the entire document *	1,4,5, 8,9	
Y	US-A-3 968 459 (SPERRY RAND CORPORATION) * column 4, lines 19-55; figures 1,3.*	1,5,6	

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

G 10 K
A 61 B
B 06 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22-02-1984	ANDERSON A.TH.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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